SUGGESTIONS FOR TRACING RELATIONSHIPS OF INSECTS.

By Nathan Banks.

In studying any group, especially when one is trying to make a synoptic table, we become interested in the relationships or affinities and try to arrange the species or genera according to our ideas of their phylogeny. Yet, I fear in many cases we proceed without any clear idea of a basis for decision. It is evident that in different groups different methods may be necessary, but there are a few considerations which I think may apply to many cases.

Some authors try to put first those forms that possess primitive characters, or the greatest number of such characters. Others take certain synthetic forms which seem to show relationships in several directions as a starting point for the group.

Everyone has observed that in any large group, as an order, there is contradictory evidence as to what is the most primitive family or genus. In Coleoptera for example, certain genera have more free ventral segments than usual, other genera have ocelli, or traces of a median suture on the head, yet some of these will not have the five-jointed tarsi.

A case familiar to me is the Hydropsychid caddice-flies. Their ancestors were near the Rhyacophilidæ and had 3, 4, 4, spurs, ocelli present, and the female with two little appendages at tip of the body. We find in the Hydropsychids that some have ocelli, but do not have the 3, 4, 4 spurs, while others have the 3, 4, 4 spurs, but not the ocelli, and various genera have the primitive abdominal appendages.

In other words primitive characters are inherent in the descendants and may be developed in various parts of the descendant series, or, more properly, retained by varying lines of descendant series, so that taking any family of existent forms several arrangements are possible according to what primitive character is chosen as the criterion.

Genera differ from other genera by at least two sets of characters. One is the positive characters, the presence or absence of a structure, the other is in accrescent characters, or developing

tendencies. The positive characters are most useful in delimiting genera (and other groups) but because of their constancy of little value in tracing relationship. It is to these accrescent characters that we should look for phylogeny.

If several species of a genus A have spines on the vertex, and an allied genus also has spinose vertex, it is not likely that these spines in genus A will indicate relationship; but if in a series of genera with bare vertex, there is a genus in which spines are present, then the arrangement and size of these spines may indicate phylogeny. Take for example the spider genus *Tetragnatha;* it has a peculiar character in the enlarged, much-toothed mandibles; a study of the increased modification and armature of these mandibles will afford clues to relationship of the species. Formerly I and others have used variations in eye-position as group characters, but these same variations in eyes occur in allied genera and so may occur in various parts of *Tetragnatha* irrespective of phylogeny.

Therefore, to my mind the best way to get at the relationships of the species of a genus, or the genera of a family, is by tracing the development of some character peculiar to the series; an accrescent character, found in varying stages of development in the group, but not found in allied groups, particularly groups that may be considered ancestral to the group in question.

There are many prominent cases where, I believe, primitive characters have deceived systematists. For example, in spiders the cribellum and calamistrum are primitive characters, and occur in groups otherwise widely separated. Several arachnologists have insisted on grouping these forms together, thus producing a most heterogeneous assemblage, whereas if they would ignore these primitive characters, and study the accrescent development of some peculiar character of spiders they would reach a better knowledge of their phylogeny; the male palpi are just such a character.

Another case is the pronotum in Hymenoptera extending to the tegulæ; Ashmead put the social and fossorial wasps together on this account; the character occurs elsewhere in the Hymenoptera, and therefore cannot be depended upon to indicate affinity. In the Lepidoptera various systems have been based on the possession of some primitive character, thus the case-forming habit of larvæ, the jugum, mandibles, number of anal veins, etc.,

have served to unite groups otherwise discordant. A careful study of the proboscis, or the scales might serve to give clues to phylogeny.

In the Coleoptera, tarsal and antennal characters have been used yet mostly in vain, the elytra, a character peculiar to the group, should be investigated. If we consider groups as large or larger than families we notice that specialization has not proceeded along one definite line, but the line of specialization is continually changing, and often accompanied by other modifications. Each change in the line of specialization marks the limits of a group of greater or less extent; one structure having reached a certain stage marks time while other structures are modified.

The Mantispidæ have peculiar front legs, having reached a certain development this structure remains fairly stable, while other structures develop. The Limnephilidæ in the Trichoptera are an example of stability in venation; generic characters are largely to be found elsewhere, while in the Sericostomatidæ venation continues to vary and aid in defining genera.

In the Diptera the Muscidæ, Tachinidæ, Dexidæ and Sarcophagidæ were defined by bare or pilose antennæ, yet genera with pilose antennæ occur in various related families. An accrescent character of these groups appears to be the chaetotaxy, and this has been used to indicate a new classification of these families.

Structural and other characters may be roughly grouped into two sections, adaptive, that is those which have been influenced by environment and habits, and atavic, or those which are of no use to the insect, and persist because they are not in the way, and have a long history back of them. The adaptive characters are of use in small groups to indicate affinity, but soon break down when applied on a larger scale.

Thus two eyeless species occurring in the same caves may be closely related when belonging to one genus, but most such eyeless cave insects are not related. As a whole adaptive characters are of little use in tracing relationships. It is the atavic, or accompanying characters, not related to a life-habit, that are the best for indicating affinity. All insects have many points of structure or color that are of no use to them. Many of these

characters are variable, and one must endeavor to find by an examination of a long series of at least a few species what characters are constant.

Atavic characters usually exist unchanged through a long series, so they are of no use (or little use) in tracing affinity within a genus. They are of most use in indicating the relationships of genera and families, and especially where insects have acquired a number of striking adaptive characters, some of which may be those of convergence and tend to conceal the true affinities.

Other points might be brought out, but at present I desire to impress upon systematists that atavic characters should be sought in the broader fields of classification, while in many studies, particularly in genera, accrescent characters should be considered, while the use of primitive and of adaptive characters should be avoided, or used only in connection with the others.